

depth of a perforated sheet, and V is an enclosed volume in a cavity;

c) forming perforations of desired dimensions through a front surface of said diffuser to create said device;

d) designing a diffusive surface shape of said diffuser to create diffusion above the crossover frequency using techniques including but not limited to number theory and acoustical optimization;

e) installing said device.

REMARKS

By this Amendment, the title and specification have been amended, Claims 1, 5, 7, 8, 9, 15, 16, 17, 18 and 20 have been amended, and it has been proposed to amend the drawings as shown in the accompanying Letter to the Draftsman, to place this application in immediate condition for allowance. At the end of this REMARKS section, a clean version of the amended specification and Claims is presented, showing the changes made thereto without underlining and brackets.

In the outstanding Office Action, the Examiner has alleged that the title of the invention is not sufficiently descriptive. The Examiner has suggested a new title and the Examiner's suggestion has been adopted.

The Examiner has objected to the disclosure for the following reasons:

First, the Examiner has objected to the use of the Trademarks "DIGIWAVES," "FLUTTERFREE," "SKYLINE" and "QRD" on pages 1, 2 and 3 without appropriate description. In this regard, a description of the device covered by the "DIGIWAVES" Trademark has been added. Amendments have been entered referring the "SKYLINE" and "QRD" devices to patents corresponding thereto, and written explanation has been added concerning the "FLUTTERFREE" device which is also, as noted, illustrated in Figures 5-7 of the present application with modifications thereto in accordance with the teachings of the present invention.

On page 7, the Examiner has noted double recitation of the reference numeral 13 and an appropriate amendment has been made to change the mention of "13" on line 21 to --23--. Concerning page 8, the issue date of U.S. Patent No. 5,401,921 has been corrected.

Concerning page 8, "holes" has been changed to --openings-- at line 10 to correct a minor informality.

The Examiner has rejected Claims 9, 14-18, 20 and 22 under 35 U.S.C. 112, second paragraph, as allegedly being indefinite. Amendments have been presented herewith to overcome these grounds of rejection. Thus, Claim 9 has been amended to read as follows:

"wherein said holes comprise a first set of holes and a second set of holes smaller than said holes in said first set of holes."

Concerning Claim 15, "significant" has been changed to --measurable--.

Concerning Claims 14 and 22, the Examiner has objected to the use of the expression "the group." This language is well established by Court precedent as a recitation in "Jepson" form. As such, no amendments are believed necessary in these claims.

In Claim 16, "the holes" has been replaced with --the slots--.

In Claims 17 and 18, the word "millimeter" has been added as suggested by the Examiner.

Finally, in Claim 20, the wording "such as" has been deleted, and the formula set forth on page 11 of the specification has been inserted at the appropriate location.

Accordingly, it is respectfully submitted that all of the claims are now fully definite under the purview of 35 U.S.C. 112, second paragraph.

In the outstanding Office Action, the Examiner has rejected Claims 1-5, 7, 15 and 16 under 35 U.S.C. 102(b) as allegedly being anticipated by U.S. Patent No. 4,964,486 to D'Antonio et al. D'Antonio is a co-inventor herein. In making this ground of rejection, the Examiner has alleged that the D'Antonio et al. patent discloses "a sound diffuser with low frequency sound absorption." This contention is false. Nowhere in the D'Antonio et al. patent is there any teaching or suggestion that the cinder block modular diffuser disclosed therein provides any sound

absorption including low frequency sound absorption. Thus, Claims 1-5, 7, 15 and 16 are free of anticipation by D'Antonio et al.

The Examiner has rejected Claims 6 and 19 under 35 U.S.C. 103(a) as allegedly being unpatentable over D'Antonio et al. as applied to Claim 1 and further in view of U.S. Patent No. 6,015,026 to McGrath. In taking this position, the Examiner incorrectly states that the D'Antonio et al. patent teaches the invention of Claim 1 (for the reasons set forth hereinabove). The Examiner concedes that D'Antonio et al. fail to disclose a front surface comprised of a compound curved shape as recited in Claim 6, and a crossover frequency below which sound is absorbed and above which diffusion takes place with reference to Claim 19. The Examiner alleges that McGrath teaches these features. However, McGrath fails to cure the deficiencies of D'Antonio et al. vis.a.vis independent Claim 1, with particular reference to the failure of D'Antonio et al. to teach or suggest sound absorption. As such, it is respectfully submitted that Claims 6 and 19 are unobvious over the combination of D'Antonio et al. and McGrath. In order to sustain a ground of rejection under 35 U.S.C. 103, the Examiner must present a *prima-facie* case for obviousness. If the Examiner fails to present a *prima-facie* case for obviousness, there is no requirement that the applicant provide any arguments to demonstrate the patentability of the claims because the burden on the Primary Examiner to provide such a *prima-facie* case has not been met. *In*

*re Thrift*, 63 USPQ 2002 (Fed. Cir. 2002). In *In re Thrift*, the Federal Circuit stated the following:

"To establish a prima-facie case of obviousness the Board must, *inter alia*, show 'some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would leave that individual to combine the relevant teachings of the references.'"

*In re Thrift*, 63 USPQ 2d at 2006.

The Examiner's burden to demonstrate a prima-facie case for obviousness has not been met in the manner required by *In re Thrift*.

The Examiner has rejected Claims 8, 13 and 14 under 35 U.S.C. 103(a) as allegedly being unpatentable over D'Antonio et al. as applied to Claim 1 and further in view of U.S. Patent No. 5,422,446 to Fries. In taking this position, the Examiner has alleged that "D'Antonio et al teach the invention of claim 1." The Examiner has next conceded that: "it is unclear whether D'Antonio et al teach the following:

"it is unclear whether D'Antonio et al teach the following: referring to claim 8, the incorporated means having a plurality of holes; referring to claim 13, an absorptive material over the rear of the body; and referring to claim 14, the absorptive material made of a porous material."

The Examiner has alleged that Fries teaches these aspects. Applicants must respectfully disagree with this position as taken by the Examiner. In particular, first of all, contrary to the Examiner's contention, for the reasons set forth above, D'Antonio

et al. fail to teach the invention recited in Claim 1. As such, insofar as the Examiner is relying upon D'Antonio et al. to teach all of the features of Claim 1, the Examiner has failed to make a *prima-facie* case for obviousness. *In re Thrift*. Fries teaches a panel-shaped element specifically described as being solely for the purpose of sound absorption (see line 1 of the Abstract). Since Fries fails to teach or suggest any aspect of diffusion, it is not seen how the Fries reference is analogous to that of D'Antonio et al. to a sufficient degree to make them combinable under 35 U.S.C. 103. When such a ground of rejection is proposed, the question must be asked as to where the Examiner has gone for the suggestion to combine these references together to meet the terms of Claims 8, 13 and 14. It is apparent that the only place the Examiner could have gone for the suggestion to combine these references together is in Applicants' own disclosure. In attempting to reject claims under 35 U.S.C. 103, there must be a reason or suggestion in the art for making the combination of features suggested by the Examiner other than knowledge learned from applicant's own disclosure. *In re Dow Chemical Company*, 5 USPQ 2d 1529, 1532 (Fed. Cir. 1988). Here, when looking at the D'Antonio et al. reference, there is no suggestion to do anything other than diffuse sound. When one looks at the Fries reference, there is no teaching or suggestion to do anything other than absorb sound. Thus, one reference is solely directed to diffusion and the other is solely

directed to absorption. It is improper to use the inventors' patent application as an instruction book on how to reconstruct the prior art. *Panduit Corp. v. Dennison Mfg. Company*, 1 USPQ 2d, 1593, 1602, fn 29 (Fed. Cir. 1987). Where the Examiner has picked and chosen various features from separate prior art references and has combined them together using Applicants' own disclosure as the blueprint to do so, such a rejection is fatally flawed. *Heidelberger Druckmaschinenag v. Hantscho Commercial Products, Inc.*, 30 USPQ 2d 1377, 1379-80 (Fed. Cir. 1994).

The Examiner has rejected Claims 9-12 under 35 U.S.C. 103 as allegedly being unpatentable over D'Antonio et al. in view of Fries as applied to Claim 8 above and further in view of U.S. Patent No. 3,862,366 to Huszty et al. In making this ground of rejection, the Examiner has alleged that D'Antonio et al. in view of Fries teaches the invention of Claim 8. For the reasons set forth above, Applicants disagree with this position. The Examiner has relied upon Huszty et al. to teach the limitations of Claims 9-12 including, allegedly, large and small holes with the sets of holes being arranged in rows. Further, the Examiner alleges that Fries teaches rows of holes located within a well of a diffusive surface and that Fries teaches the holes located across a plurality of wells. The Examiner's contention that Fries teaches a diffusive surface is incorrect. The Fries disclosure is limited to a sound absorbing panel. While Huszty et al. teach a structure having

large and small holes, that structure is neither an absorber nor a diffuser. It is merely a grill described by Huszty et al. as a "lamellar obstacle." This device is disclosed by Huszty et al. as being provided to produce "diffraction." Diffraction is neither diffusion or absorption. As such, this proposed ground of rejection fails to establish a *prima-facie* case for obviousness.

*In re Thrift.*

The Examiner has rejected Claims 20-24 under 35 U.S.C. 103(a) as allegedly being unpatentable over U.S. Patent No. 5,892,187 to Patrick in view of D'Antonio et al. and further in view of McGrath. Referring to Patrick, the Examiner alleges that Patrick teaches:

"making an acoustical device by calculating the number of perforations using an equation."

Patrick fails to teach or suggest a device which diffuses sound. Rather, Patrick teaches a sound absorbing headliner for a passenger cabin of a vehicle. There is no teaching or suggestion that Patrick uses his device to diffuse certain sounds and absorb others. Thus, there is no reason to modify Patrick in view of D'Antonio et al. and McGrath. In fact, modifying Patrick in view of D'Antonio et al. and McGrath would destroy Patrick for its intended purpose. If D'Antonio et al. taught providing perforations in a diffuser as alleged by the Examiner (there is no such teaching in D'Antonio et al.), applying that teaching to Patrick would destroy Patrick for its intended purpose because providing perforations in a sound absorbing headliner in a vehicle

would increase the incursion of sounds within the passenger cabin, a result diametrically opposite to the purpose of Patrick. Again, the Examiner's contention that D'Antonio et al. teach forming perforations of desired dimensions through a front surface is false. D'Antonio et al. teach providing wells of desired depths into a front surface. This is specifically set forth in the location in D'Antonio et al. quoted by the Examiner, namely, column 2, lines 21-25. The disclosure is as follows:

"In the preferred embodiment of the present invention, a plurality of cinder blocks are manufactured having predetermined numbers of wells therein of predetermined depths in accordance with the quadratic-residue number theory sequence...".

Since D'Antonio et al. fail to teach that which the Examiner alleges they teach, and since the D'Antonio et al. patent is uncombinable with Patrick, there is no need to go any further. In the same manner as is the case in the rejection seeking to combine D'Antonio et al. and Fries, the teachings of Patrick and D'Antonio et al. are mutually exclusive. Patrick teaches sound absorption. D'Antonio et al. teach sound diffusion. The only way in which the Examiner can combine these references together is through the hindsight reconstruction of the prior art in light of Applicants' own disclosure. Again, it is improper to use the inventors' patent application as an instruction book on how to reconstruct the prior art. *Panduit Corp.* Where the Examiner has picked and chosen various features from separate prior art references and has

combined them together using Applicants' own disclosure as the blueprint to do so, such a rejection is fatally flawed. *Heidelberger Druckmaschinenag.*

The Examiner's indication of the allowability of Claims 17 and 18 is appreciated. However, based upon the arguments set forth hereinabove, it has been deemed unnecessary to rewrite those claims in independent form.

In order to clarify independent Claim 1, independent Claim 1 has been amended to replace the language "means incorporated into said front surface" with "means receiving sound waves via said front surface." This amendment is believed to clarify the subject matter of independent Claim 1 and appropriate amendments have been made to dependent claims to render them in conformance thereto.

For these reasons, it is respectfully submitted that the application is now in condition for allowance. Reconsideration and allowance of the application are respectfully solicited.

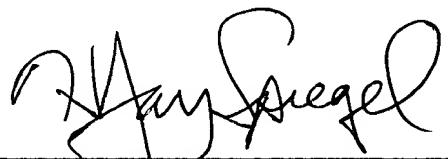
If, for any reason, the Examiner believes that an interview with Applicants' Attorney would be helpful in expediting the prosecution of this patent application, the Examiner is respectfully requested to telephone Applicants' Attorney locally at (703) 619-0101 so that a discussion of any outstanding issues may be had.

Again, reconsideration and allowance of this application are respectfully solicited.

Respectfully submitted,

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## SOUND DIFFUSER WITH LOW FREQUENCY SOUND ABSORPTION

BACKGROUND OF THE INVENTION

The present invention relates to a sound diffuser with low frequency sound absorption. When sound is incident on a surface, 5 the sound energy may be absorbed or reflected. The reflected sound can either be concentrated in one direction, in the case of specular reflection, or spread in many directions when it is diffused. Historically, sound treating surfaces have been designed either to be absorbing or diffusing, but a surface that can 10 incorporate some absorption while also diffusing any reflected sound may be of use to designers. Applicants and Applicants' Assignee have developed binary amplitude diffusers (U.S. Patent No. 5,817,995) as well as an acoustical device known by the Trademark "DIGIWAVES" which consists of a hybrid, binary amplitude, curved 15 surface consisting of absorptive and reflective elements, whose relative locations and surface curvature are determined using optimization techniques to yield a surface that provides uniform diffusion. However, a need has developed for a hybrid diffuser-absorber that divides absorbed sound from diffused sound based upon 20 a transition frequency. It is with this thought in mind that the present invention was developed.

RPG DIFFUSOR SYSTEMS, INC. has previously disclosed a mounting method for its diffusing devices that provides low frequency absorption, by providing slots or spaces between diffusing 25 elements. These spaced diffusing elements are mounted with a rear air cavity including a porous absorption panel on the rear surface

of the diffusing device. The present invention distinguishes itself from this mounting method, by providing a series of means, via holes, slots or microperforations, for low frequency absorption within the body of the diffusing device, as opposed to between 5 devices, thereby providing diffusion and absorption in a self-contained device.

#### SUMMARY OF THE INVENTION

The present invention relates to a sound diffuser with low frequency sound absorption. The present invention includes the 10 following interrelated objects, aspects and features:

(1) In a first aspect, the present invention may be practiced by performing modifications on existing diffusers as they are known in the prior art. In this regard, means are incorporated into a diffusive surface to provide sound absorption below a pre-set 15 frequency.

(2) In a first example of such a modification, Applicant's Assignee manufactures a diffuser consisting of a hardwood architectural molding known by the registered Trademark "FLUTTERFREE®". The FLUTTERFREE® device consists of an extruded 20 wood plank with surface topology based on the quadratic residue number theory sequence, and offers mid and high frequency diffusion. When slotted in the manner described hereinbelow, the FLUTTERFREE® device also offers low frequency absorption below the lower frequency cut-off for diffusion. As seen in Figures 5-7, the 25 "FLUTTERFREE®" diffuser may be modified by creating through-holes in certain wells of the diffuser that allow sound to travel through the diffuser to the rear thereof where an absorptive material may

be located. The absorptive material may be made of any suitable material such as fiber glass, foam or mineral wool. As will be described in greater detail hereinafter, the cut-off frequency between diffusion and absorption may be "tuned" or adjusted by 5 varying the total volume of holes made within the diffuser, and by determining the particular cavities (and their depths) which are chosen to be modified through the provision of holes.

(3) In a second embodiment of the present invention, a two-dimensional diffuser may be modified through the provision of holes 10 or slots. As an example, Applicant's Assignee's patented "SKYLINE®" diffuser (U.S. Patent No. 5,401,921) may be modified through the provision of holes or slots formed in the narrow channels between two-dimensional blocks used to create "wells" therein. As in the case of the "FLUTTERFREE®" diffuser, the 15 frequency cut-off between diffusion and absorption may be suitably adjusted by adjusting the locations of the holes or slots and the total volume of holes.

(4) In a further example, a "QRD®" diffuser (U.S. Patent No. D291,601) may be modified by placing holes or slots within one or 20 more of the wells thereof. Again, as before, the frequency cut-off between diffusion and absorption may be suitably adjusted through holes or slots formed in particular wells and by adjusting the volume of holes within the diffuser as a whole.

(5) A further example of the teachings of the present 25 invention may be applied to a diffusive surface which may be best described as a compound curved shape. Such a shape may be modified through the provision of holes and/or slots formed in various

Figure 15 shows a graph depicting the combined absorption and diffusion of a device made in accordance with the teachings of the present invention.

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#### SPECIFIC DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is first made to Figures 1-7 so that a description of a first embodiment of the present invention may be made.

With reference to Figures 1-7, a first embodiment of the present invention is generally designated by the reference numeral 10 and is seen to include a generally rectangular body 11 having a plurality of forward facing wells that are vertically elongated and have differing depths according to a calculated pattern designed to optimize diffusion. The wells are designated by the reference numerals 12, 13, 14, 15, 16 and 17.

15 As best seen in Figures 1 and 4, the device also includes three rearward facing wells 18, 19 and 20.

With reference to Figure 3, an example of the modification of the device 10 as previously used solely as a diffuser is seen to include a plurality of holes 21 of generally rectangular shape 20 formed at spaced intervals along the wells 13 and 16. As best seen in Figure 4, an absorptive covering 23 is placed rearward of the device 10 so that sound waves traveling through the holes 21 are suitably absorbed. The material for the absorptive covering 23 may be, for example, fiber glass, mineral wool or foam. A further

example of a pattern of holes formed in a diffuser is illustrated in Figures 5-7, wherein a "FLUTTERFREE®" diffuser 10' is seen to include vertically elongated wells 12', 13', 14', 15', 16' and 17'. In the example shown, it is seen that the wells 13' and 16' each have a plurality of relatively large holes 25 therethrough, while the wells 12', 14', 15' and 17' have rows of relatively small holes 27 therethrough. This pattern of holes as extending through the rear surface of the device 10' is seen with reference to Figure 6. As seen in Figure 7, an absorptive covering 23' is provided on the rear face of the device 10' to absorb any sound waves emanating through the holes 25, 27. The holes 27 may be considered micro-perforations.

With reference, now, to Figures 8a-10, a two-dimensional diffuser known by the registered Trademark "SKYLINE®" is generally designated by the reference numeral 30 and is seen to have sides 31, 33, a top side 35, and a bottom side 37. The "SKYLINE®" diffuser is disclosed and claimed in U.S. Patent 5,401,921 issued March 28, 1995. As seen in particular in Figure 8a, a plurality of rectangular regions 39 are separated by slots 41 formed therebetween to form a grid pattern. The rectangular regions shall include but not be limited to shapes described by reference numerals 39a-e (See Figure 8b). In accordance with the teachings of the present invention, with reference to Figures 8a-10, openings 43 are created in the slots 41 at spaced locations

therein, which openings 43 extend through to the rear surface 45 of the device 30. As best seen in Figures 9 and 10, an absorptive device 47 is mounted on the rear surface 45 of the device 30 to absorb any sound waves that travel through the openings 43.

5 With reference to Figures 11-13, a "QRD®" diffusor is generally designated by the reference numeral 50 and includes a generally rectangular cubic body 51 having elongated wells 53, 54, 55, 56, 57 and 58 formed therein. As seen in Figure 12, rectangular openings 59 are formed in the wells to allow sound to 10 travel therethrough to the rear surface of the diffusor. The openings 59 may be provided in a vertically spaced pattern in each of the wells.

In addition, small sized holes 61 may suitably be provided. 15 As best seen in Figure 13, the rear surface 63 of the device 50 is covered by an absorbent material covering 65 designed to absorb sound waves traveling through the holes 59 and 61.

Figure 14 depicts a compound curve-shaped diffuser 70 that may be modified in accordance with the teachings of the present invention as exemplified in Figures 1-13 through the provision of 20 any desired pattern of holes, slots or openings extending through to the rear surface thereof, which rear surface may suitably be covered by a sound absorbing material as should be understood from the teachings of the present invention as explained with reference to Figures 1-13.



CLAIMS

1. A sound diffuser with low frequency sound absorption, comprising:

a) a body having a front surface configured to diffuse sound waves; and

b) means receiving sound waves via said front surface for absorbing sound waves below a desired cut-off frequency.

5. The invention of Claim 4, wherein said receiving means is formed in said slots or holes.

7. The invention of Claim 1, wherein said receiving means comprises a plurality of open slots.

8. The invention of Claim 1, wherein said receiving means comprises a plurality of holes.

9. The invention of Claim 8, wherein said holes comprise a first set of holes and a second set of holes smaller than said holes in said first set of holes.

15. The invention of Claim 7, wherein the slots are narrow enough to provide measurable low frequency absorption.

16. The invention of Claim 7, wherein the slots are narrow enough to provide significant low frequency absorption.

17. The invention of Claim 15, wherein said slots have a width of 0.1 millimeter to 1 millimeter.

18. The invention of Claim 16, wherein said holes have a diameter of 0.1 millimeter to 1 millimeter.

20. A method of making an acoustical device which absorbs sound below a crossover frequency and diffuses sound above said crossover frequency, including the steps of:

- a) choosing a desired crossover frequency;
- b) calculating a number of perforations to be formed in an existing diffuser and their respective areas by using an existing standard acoustic formulation:

$$f = \frac{c}{2\pi} \sqrt{\frac{S}{LV}}$$

where  $f$  is the peak absorptive frequency,  $c$  is the speed of sound in air,  $S$  is the cross-sectional area of a hole,  $L$  is the apparent depth of a perforated sheet, and  $V$  is an enclosed volume in a cavity;

- c) forming perforations of desired dimensions through a front surface of said diffuser to create said device;

d) designing a diffusive surface shape of said diffuser to create diffusion above the crossover frequency using techniques including but not limited to number theory and acoustical optimization;

e) installing said device.